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A PLAN TO ADDRESS THE HAWAIIAN MONK SEAL ADULT MALE "MOBBING" PROBLEM

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INTRODUCTION

The Hawaiian monk seal, Monachus schauinslandi, is an endangered species which has experienced more than a 50% decline since the late 1950's. One reason the populations at some locations are not recovering may be that adult male monk seals kill adult females and immature seals during mass mating attempts (mobbings).

A workshop on the Hawaiian monk seal adult male mobbing problem was held at the National Marine Fisheries Service (NMFS), Southwest Fisheries Center (SWFC) Honolulu Laboratory, 17-20 February 1987, to explore possible solutions, and from these develop a plan of action to be initiated at Laysan Island and adapted later, as may be necessary, to other locations. The SWFC Marine Mammals and Endangered Species Program invited nine scientists to participate in developing the plan along with eight researchers from the program (Appendix 1). Representatives from the U.S. Fish and Wildlife Service and the State of Hawaii, Department of Land and Natural Resources, were invited to observe. In addition, interested parties from NMFS, the Waikiki Aquarium, the University of Hawaii, and the private sector (including Sea Life Park) were invited to attend the preliminary overview presentations on program research and recovery activities.

Representation in the working group was planned to include people with extensive and recent experience with Hawaiian monk seal research, those with experience working with other pinniped species, and some participants with special areas of expertise including genetics, reproductive biology, and behavior.

The objective of the workshop was to develop and present a plan to address the mobbing problem. This report presents 1) the process by which the plan was derived, and 2) the plan, itself. It does not include the research findings and other observational information which were presented to the workshop participants nor does it include the full workshop discussions which resulted in the final plan.

PLANNING PROCESS

Overview

Prior to the workshop, non-program participants were mailed background information on monk seal behavior and mobbing. The first 1-1/2 days of the workshop consisted of presentations by NMFS program staff, to ensure everyone had a basic background in monk seal biology and the mobbing problem. During the final 2-1/2 days participants discussed needs relative to the mobbing problem, and developed the plan; these sessions were led by a trained "facilitator" who involved all participants in the planning process and emphasized direct communication among them.

Background Presentations

The list of background presentations given at the workshop is in Appendix 2. Questions were discussed as they arose, or, when appropriate, later after relevant data were assembled.

Strategic Planning

A general discussion of what needed to be considered to reduce mobbing followed the presentations. It was the understanding of the group that basic monk seal census work, pup tagging, and the Kure "Head Start" project would continue as priority activities of the program, and any research on the mobbing problem proposed by this workshop would be conducted as funds may be available above the level required to support those priority items.

Three primary subject areas were identified in the discussion:

1) Basic questions about mobbing to focus analysis of data and further research, 2) Long-term marking of study animals, and 3) Removal of males. Participants broke into three groups, each group to develop ideas about one of the above topics. When participants reconvened, each group outlined its discussions (Appendix 3), and then the entire group identified further activities that might be undertaken to address each of the three topics. All of the activities listed were then divided into two general categories: Proposed Data Analysis Activities (Appendix 4) and Proposed New/Expanded Research Activities (Appendix 5). Individual items from these two lists were organized into categories, and similar items were linked together. The entire process leading to development of the plan is outlined in Figure 1.

The group then selected (via verbal vote) and discussed nine items that were considered of top priority (Appendix 6). Only one of these, "Behavior Modification," was an action intended to actually reduce mobbing activity. Behavior Modification (Appendix 7) was evaluated in terms of the following: Will it promote recovery? What check points for evaluation are needed? What are the criteria for success? When should the activity be stopped or re-evaluated? The other eight activities were then evaluated in terms of their relationship to behavioral modification (Appendix 8). The nine activities were then ranked in importance (Appendix 9a), consideration being given to whether these activities might directly impact the course being taken toward behavior modification. Though initially ranked highest, "monitoring adult male behavior at Kure" was moved to the low end of the priority listing after its significance was defined. Three levels of importance emerged (Appendix 9b). The group discussed the items ranked, and discussed items which did not appear in that listing to make certain nothing "fell through the cracks." Worst case scenarios and safeguards were also discussed.

Drafting the Plan

Individual participants then took the list of activities (Appendix 4 and 5) and defined each one according to the intent of each as described

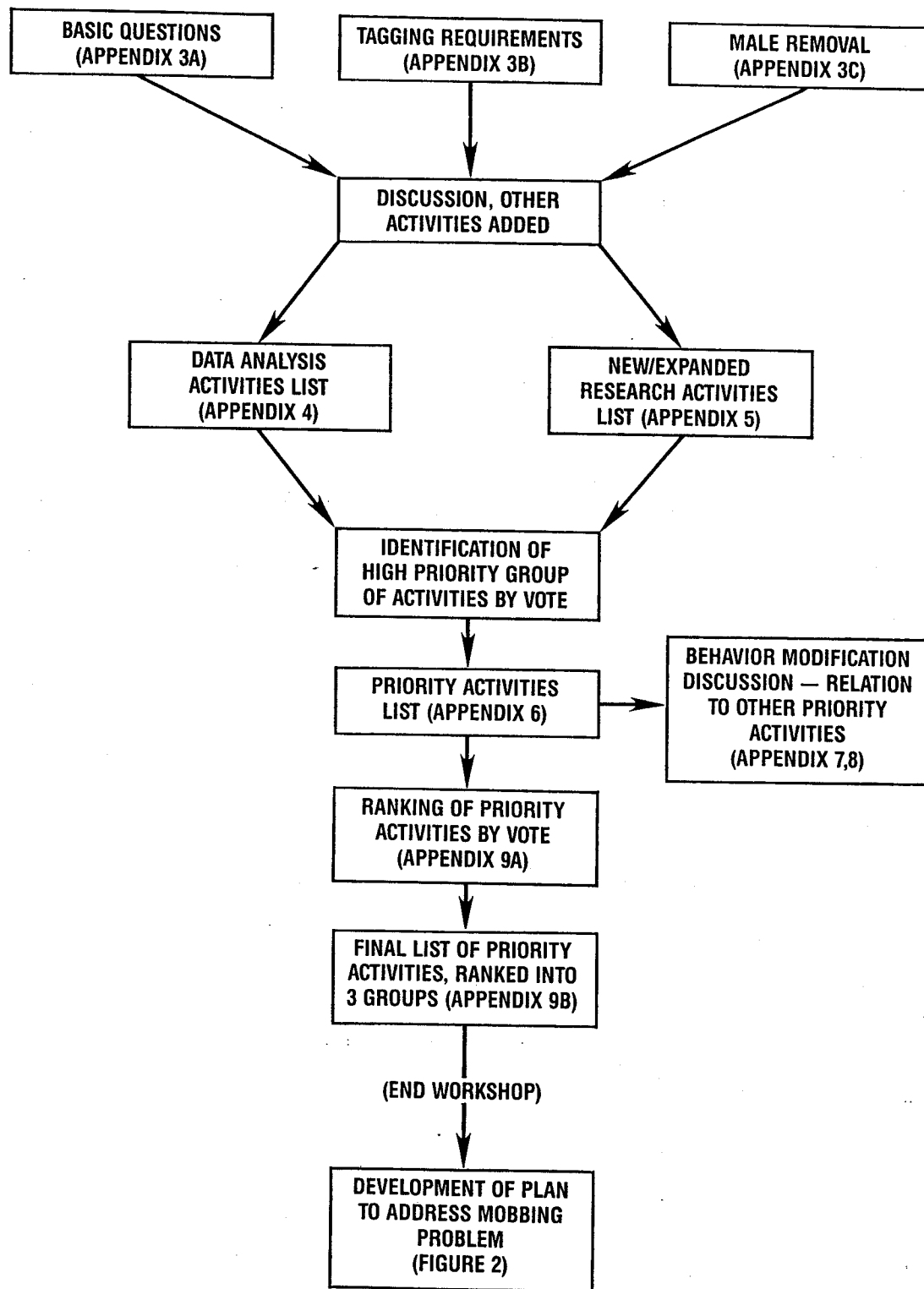


Figure 1.--Process leading to development of the plan to address the Hawaiian monk seal mobbing problem.

the previous day. This terminated the formal workshop. Marine Mammals and Endangered Species task members then completed the writing, organized this report, and referring to the three levels of priority, drafted the "plan." A draft of this report, including the plan, was sent to participants for comments before final printing.

The Plan

The plan was developed based on the concerns and priority actions identified by the workshop participants and appears in Figure 2. The plan, as initially envisioned, is directed at reducing the number of mobbing incidents by causing the adult sex ratio to move toward unity, possibly by physical removal of up to 50% of the adult males at Laysan Island. However, continued monitoring of the population, including mobbing activity, female survival and pup production, along with further analysis of existing data and, data from certain new studies, may result in reducing this percentage or eliminating the need to remove any animals. Understanding these data will allow evaluation of the need to remove seals and the benefit/risk ratio of such action.

Physical removal of a large number of males is considered an irreversible action, and some concern was expressed that sudden and permanent removal of up to 50% of the adult males may disrupt the adult male social hierarchy with a consequential decline in birth rate, despite the fact that apparently dominant males would not be collected. For practical reasons, removing many adult males must be permanent because maintaining them in captivity for possible reintroduction to Laysan Island would require isolation from other pinnipeds and other wildlife and domestic animals until the time of possible reintroduction to ensure no new diseases would be taken into the Northwestern Hawaiian Islands population.

Therefore, prior to physical removal of animals from Laysan Island, considerable effort will be devoted to developing and testing techniques to modify aggressive behavior of adult males. An alternative approach was identified at the workshop which would test the effect of removing these males prior to any such permanent action. Because mobbing activity is limited to the peak of the breeding season and involves only adult (and possibly subadult) males attacking all other age and sex groups, the behavior is probably linked to seasonal testicular activity. Increased pituitary function, driving an increase in testicular androgen production is generally associated with increased male aggressiveness and related male advances toward females or other non-androgenized individuals. A reversible chemical treatment of males is proposed in this plan to block the seasonal increase in testicular androgens and, hopefully, the aggressive behavior. This treatment would be conducted during one to two breeding seasons in order to evaluate the effects of chemically "removing" this large number of males from the breeding population. The potential benefits and potential problems, if any, resulting from physical removal may then be more predictable. Before such treatments can be used in the wild, however, research into drug type, dose, delivery, and safety of the treatments must be performed on captive monk seals to ensure optimum effectiveness of the

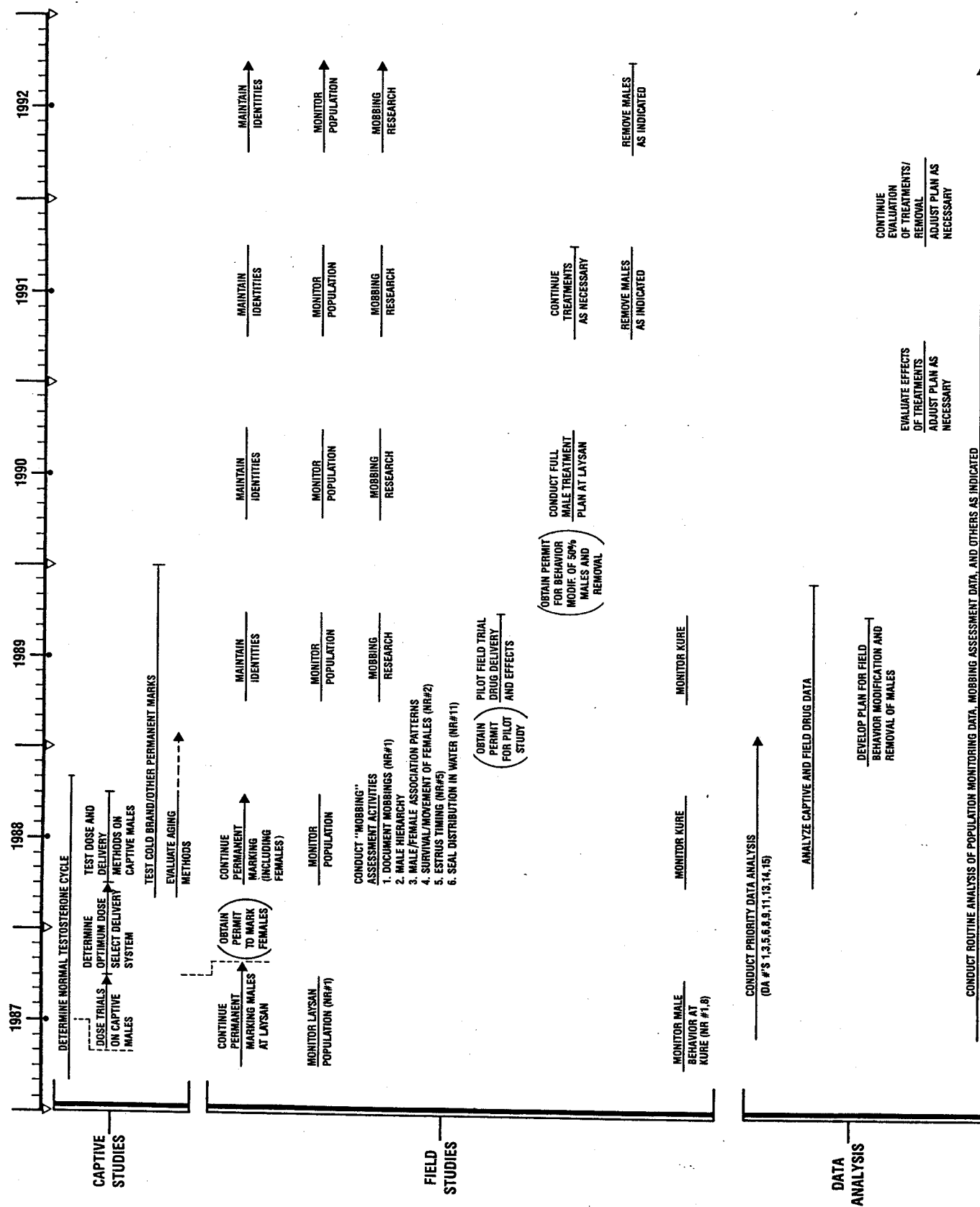


Figure 2.--Plan to address adult male mobbing problem.

technique. Therefore, two to three breeding seasons of testing will be necessary before a large number of adult male seals could be dosed at Laysan Island. During this time other research and data analysis on the causes and effects of mobbing will continue.

Most of the critical research associated with this plan requires maintaining identities of individual seals of both sexes over a long period of time. The program currently has a permit to flipper tag all male seals at Laysan Island and this tagging began in 1986. All pups of both sexes weaned prior to and during the annual field camps have been tagged since 1983 under existing permits, and this effort will continue. Female monk seals, other than weaned pups, have not been tagged as part of any NMFS research to date, although they have been bleach marked. It is not possible to use bleach marks to follow individuals over many years, because the field camp schedules do not cover the entire period each year during which the females may molt. Therefore, workshop participants recommended that a female tagging program at Laysan Island be initiated as soon as possible, but not during the breeding season.

Tag type, retention characteristics, and method of application (requiring restraint or not) should be evaluated to select the best tag for identifying females, considering that disturbance in application must be minimized. The program should start with tagging 50% of the untagged immature and adult female seals at Laysan Island, in a controlled evaluation of the effects of the tagging. Immature females should be tagged first, with tagging of adults following, if the disturbance caused is within acceptable limits. It was further recommended that the adult female tagging be performed in October-December, well after the breeding season and several months before pupping. The remaining 50% of the females should be tagged as soon as possible following acceptable results in the tagging effects study.

Additionally, some of the data analysis identified as high priority by the participants is ongoing. This work will be expanded to include the additional tasks defined in this plan. Five adult males have been collected in order to begin the captive hormone research during the current breeding season. An evaluation of the retention characteristics of the metal tags currently being applied to subadult and adult males will begin following data collection at Laysan Island this year to determine if these tags may be acceptable for females, since they can be applied without restraint of the seal. A permit application to tag females will follow that analysis. If the work proposed in this plan progresses on schedule, the decision whether to physically remove adult male seals from Laysan Island will not be made until at least 1990, and it will take into account as much information as possible on the long-term effects of such actions on the recovery of this species.

As stated earlier the workshop participants were concerned that the current recovery and population monitoring efforts in the program continue and take priority over the proposed activities to reduce mobbing. Therefore, in order to manage significant action on this problem and continue these other activities, implementation of the plan according to

the time base proposed (Fig. 2) will not be possible without additional resources during the next few years. While some progress will be possible at the current funding level, an additional 2.0 man-years of effort with associated field support costs (a total of about \$45K per year) will be necessary during the next 2 years in order to maintain the proposed schedule and resolve many of the questions raised at the workshop. This will enable the critical decisions about reducing female mortality to be made as soon as possible.

Appendix 1.--List of working group participants.**Invited Scientists:**

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NMFS Marine Mammals and Endangered Species Program Participants:

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Alcorn, Doris J.
Banish, Linda D.
Forsyth, Robert G.
Gerrodette, Tim
Henderson, John R.
Johanos-Kam, Thea C.
Westlake, Robin L.

Appendix 2.--Workshop presentations on monk seal research and recovery work.

1. General biology (Henderson)
2. Pupping habitat (Westlake)
3. Kure "Head Start" and FFS pup rehabilitation (Gilmartin)
4. Energetics research (Whittow)
5. Population dynamics, trends, monitoring (Gerrodette)
6. Interisland movement patterns (Alcorn)
7. Survival (Johanos-Kam)
8. Adult male removal from Laysan 1984 (Forsyth)
9. Monk seal surgery (Gilmartin)
10. "Mobbing:" Background information through 1986 (Alcorn)
11. "Mobbing:" 1985 study, methods and findings (Johanos-Kam and Gerrodette)

Appendix 3.--Primary subject areas identified in initial discussions.

A. Questions to guide data analysis and research:

1. Is mobbing slowing population growth?
2. What causes mobbing?
 - a. genetic deviants (unlikely)
 - b. aberrant age structure (unlikely)
 - c. adaptive behavior for males (likely)
 - sex ratio favoring males
 - habitat considerations
 - d. females not giving clear cues when in estrus (likely)
3. Why do males stay in island populations where mobbing occurs?
4. Why do females stay in island populations where mobbing occurs?

B. Tagging requirements/considerations:

1. Maintain records of animals tagged to date.
2. Tag all subadults, 1/2 adult females (50:50, scarred:unscarred).
3. Continue tagging males of all ages and weaned pups of both sexes.
4. What to tag with:
 - a. Temple
 - b. tattoo (test on captive seals)
 - c. cold brand (test on captive seals)
 - d. metal
5. When to tag females - Fall.
6. Permits: Specify numbers including allowance for some mortality.
(If adult females tagged, track reproductive rates and movement patterns for effects.)

C. Considerations in removal of adult males:

1. Chemical behavior modification (agonist or antagonist of GNRH):
 - a. define annual pattern of circulating testosterone.
 - b. perform acute tests to determine optimum drug and dose to control.
 - c. test delivery system enabling seasonal control of androgens.
 - d. perform field study on up to 50% of adult males at Laysan Island.
 - e. advantages: reversible, general interest for mgmt. of other species.
 - f. disadvantages: treated males may become targets, expensive, might decrease future ability to compete.

2. Physical removal:
 - a. remove some for captive studies.
 - b. could slowly continue removal, a few per year.
 - c. primary disadvantage: probably not reversible, very expensive.

Appendix 4.--Proposed Data Analysis Activities.

DA1. Determine pattern of adult male abundance at Laysan Island when individual females are known to be near estrus. Does beach abundance decline during mobbings?

Although it is unclear whether normal aquatic mating involves more than one male, it is possible that aquatic mobbing events result in a decrease in the abundance of adult males on shore during the event and possibly for some time before and after the event. Analyze male count data for an inverse correlation on days of known mobbing events. Correlate daily counts with injury sightings to determine whether decreased abundance may indicate occurrence of unobserved mobbings. Use data from Laysan and Lisianski Islands only as intra-atoll movement at French Frigate Shoals and Pearl and Hermes Reef would preclude meaningful analysis.

DA2. Determine whether emigration rate of adult females from Laysan Island is different from other breeding areas.

Mobbings and resultant injuries have been observed at Laysan Island more frequently than at any other NWHI location. This may cause adult females to migrate to other islands to give birth and mate. Existing data on known adult females from Laysan Island and the other major breeding islands should be compared to determine whether the net movement of females from Laysan Island is different from the other locations.

DA3. Prepare and analyze population projections from past to present.

Current estimates of survival rates in monk seals are so high that, if they had held in the past, the monk seal population should have grown and still be growing. Is the discrepancy between projections based on these survival rates and the observed abundance today due to any identifiable problem, such as mobbing mortality? What survival rates are necessary to account for population trajectories over the last 10 years, and what part of the mortality can be ascribed to mobbing?

DA4. Determine reproductive, survival rates, and interisland movement patterns of mobbed versus non-mobbed females.

Use present data, as available, on known females to calculate vital rates and determine how mobbing may be affecting the population. Continue effort to monitor known females, and expand monitoring program, as may be possible, to ensure adequate data to estimate these rates. These estimates will aid in a final determination of whether to proceed with control and removal of some males from the Laysan Island population, and will be used to monitor the efficacy of such action.

DA5. Investigate spatial distribution of animals during the breeding season relative to habitat type and feeding grounds.

Since it is not known where monk seals normally breed, a study of the aquatic distribution of adult males and females from March through June would aid in identifying where this occurs. If possible, additional research might then be planned to attempt to observe matings, and the associated behavior patterns.

DA6. Investigate onset of estrus.

From further analysis of existing data, test for any apparent physical or behavioral changes in the female which may indicate estrus. This may shed light on the normal cues and stimuli which elicit male courtship and mating behavior. This in turn may help identify normal and abnormal female behavior in tasks listed under proposed research activities.

DA7. Determine if female monk seals actively select mates.

Although analysis of reproductive behavior data has emphasized male activities relative to maintaining consort with a female, female receptivity and resultant behavior may be important in determining male/female pairings. Existing data on male/female pairs should be examined for differences in female behavior toward different males within a short timespan (i.e., not related to change in estrous cycle). Ideally, behaviors toward successive male consorts of apparently different male dominance stature should be compared.

DA8. Focus data analysis (of items DA6 and DA7) on post-weaning females.

The purpose of this is to focus attention on females for which we have a known point in their reproductive cycle. This will make it possible to compile the data from many animals onto a common baseline to analyze for trends. It will also enable more efficient future observational studies.

DA9. Analyze present data for factors which may affect events in the females' behavioral and physiological cycles.

Determine whether intervals between pupping, weaning, molting, and next birth event contain information about differences in reproductive abilities and strategies among females, and about possible causes of mobbing behavior. Are females being mobbed as a result of not being bred on their first follicular cycle? Can we distinguish between females which may become pregnant on their first cycle and those fertilized later?

DA10. Investigate behavior patterns of females at Laysan that have emigrated versus females that have not.

Using present data on adult females, test for differences in behavior/activity between these groups of females to determine whether there may be patterns related to mobbing which causes females to move.

DA11. Determine the long-term trends in sex ratios at all major breeding islands.

Examine sex ratios at birth and within the several size classes over time to determine whether any trends are apparent and if trends may be correlated with mobbing behavior. Results of these tests will address the urgency with which the mobbing problem should be resolved.

DA12. Determine the ages of mobbed females that die as a result of the attacks.

The possibility exists that females themselves may elicit mobbing by adult males. A simple parameter that can be obtained from females that are killed (if the carcass can be recovered) is their age. As may be possible, the ages of all females killed in mobbing incidents should be determined and the data examined for trends.

DA13. Determine the hauling and association patterns of mobbed and non-mobbed adult females.

Spatial and temporal aspects of female hauling as well as which males they are in consort with prior to entering the water and being mobbed and their general association patterns prior to mobbing should be examined. This may lead to some insight into what triggers mobbing behavior.

DA14. Examine the distribution of post-weaning females at French Frigate Shoals.

Most of the pupping and nursing activity at French Frigate Shoals occurs at East, Round, and Whale-Skate Islands, but these islands (except Whale-Skate, to some extent) are used little by adult females at other times. Where the post-weaning females haul out may provide interesting data to compare to Laysan Island hauling patterns. "Local" seal densities and sex ratios at the other islets may result in different male breeding strategies, especially during the "wave" of post-weaning females following the peak of pupping. Research on this subject should be initiated once these locations are determined, if such observational work can be conducted with little disturbance.

DA15. Compare wounding rates of adult females, all females, and all seals by time of year and island.

From existing data collected in a standardized manner, compare male inflicted wound rates over time of adult females, all females, and all seals among all island populations. Compare these data from French Frigate Shoals by island within the atoll. This information will lead to a better understanding of the relative importance of this problem at Laysan Island and it will serve as a method of monitoring the effects of any corrective management action taken to resolve the problem.

DA16. Determine movement patterns of seals injured by adult male attacks.

Seals injured by an attack of adult males might be expected to emigrate to a location at which fewer mobbings occur. Existing data on interisland movement should be examined to assess whether seals with dorsal scars from mobbings have different movement patterns than their unscarred counterparts. Hindering this analysis is uncertainty of the island of origin of the injury.

DA17. Characterize mobbing wound healing rates.

Determine the temporal pattern of changes in the wounds resulting from mobbings to allow an estimate of the time of initial injury. This information will help in determination of the peak time of attacks and, to some degree, whether repeat injury occurs to a given animal.

Appendix 5.--Proposed new/expanded research activities.

NR1. Perform a comparative study of percent scars and fresh wounds, association patterns, and animal condition among the major breeding island populations.

This study will provide current information with which the several breeding populations can be compared. This may help in understanding the basis for the observed mobbing behavior and how it correlates with sex ratio, island and nearshore topography, and hauling and association patterns. It will also provide a baseline for comparison of the effects of any future management actions directed at reducing mobbing activity.

NR2. Compare birth rates and survival of mobbed and non-mobbed adult females.

Although mobbings have been documented to lead to serious injury and death or disappearance of the female within a few days of the attack, more subtle effects on the female are not known. For females who survive a mobbing, are subsequent reproductive and survival rates comparable to non-mobbed females?

NR3. Maintain identities of known adult male "mobbers" and determine if the behavior persists over time.

Males involved in mobbing attacks may be young males which will "outgrow" the behavior, habitual mobbers which will continue the behavior the remainder of their reproductive life, or males only occasionally involved in these events. Permanently marking males along with a continuing program of monitoring mobbing events to identify animals involved will aid in evaluating the probability of success of removal of males as a method of mitigating this mortality. This study should be planned for a population where mobbing occurs, but removal of males is not anticipated for several years, such as Lisianski Island.

NR4. Determine age of seals involved in mobbings, as well as any seals which may be dominant individuals.

Although the ages of seals which mob are not known, the individuals are thought to rank low in the dominance hierarchy. It is thus not known if mobbing results from an unbalanced sex ratio, an aberrant age structure, an aberrant male social structure, or some combination of these. A single tooth for age determination should be removed from mobbers and from dominant seals to test the relationship of age to this problem. This may help clarify the cause of the behavior and help assess any effects removal of mobbers would have on the age structure of the male population.

NR5. Determine the time estrus occurs in the monk seal.

Although existing data indicate estrus occurs sometime between weaning and molting for parturient females, focal observations of females from weaning to molt directed at determining behavior and physical evidence of estrus must be performed. The mobbings of females appear to occur over a 6-week period ranging from the first possible ovulation until three potential ovarian cycles have occurred. This may indicate two patterns of ovarian activity: a) rapid follicular development leading to a single mating and conception, which is supported by existing association data, and b) a second set of females which show several "attractive" periods extending until 6 weeks post-weaning. This study will help resolve this indication of a bimodal estrus pattern.

NR6. Define female movement patterns during the breeding season.

This work may lead to identification of the areas where normal breeding activity is occurring. Follow-up studies may be able to determine which males and how many males frequent these sites. At present there is no information available on "normal" mating with which the observed mobbing incidents can be compared. Findings of this research may help direct management of the mobbing problem.

NR7. Investigate the behavior of non-adult females that are mobbed.

Determine whether there are certain behavior patterns exhibited by immature male and female monk seals which may increase the probability they will be mobbed.

NR8. Monitor the monk seal population at Kure Atoll closely for mobbing activity.

The adult male population at Kure Atoll is believed to consist primarily of old animals. The pup Head Start project and female pup relocation program have greatly increased the number of immature females at Kure Atoll. These females are now becoming reproductive in a population with an adult sex ratio very highly skewed toward males. Mobbing of these newly recruited females by these old males would negate the hypothesis that mobbers are only young and inexperienced seals. Some insight into whether young inexperienced females elicit mobbing activity is also possible.

NR9. Characterize the traditional circulating reproductive hormone patterns in captive females during the breeding season.

These measurements may be correlated with subtle anatomic and/or behavioral changes which will lead to easier detection of estrus in the field. Strategies of detection of hormone levels in the captive females (such as from urine or feces) can be investigated for application to studies in the field.

NR10. Study behavioral interactions of captive male and female seals.

Determining estrus in free ranging seals can be facilitated if behavioral cues are known. By observing the interactions of adult male and female seals in captivity, while monitoring female hormone levels, it may be possible to ascertain changes in behavior which accompany physiological estrus. Knowledge of these behaviors can then be used in the field to assess a female's reproductive state.

NR11. Investigate underwater vocal behavior and distribution that may lead to identification of breeding sites.

Knowledge of age and sex specific vocalizations and their temporal and spatial distribution may enable identification of areas where "normal" breeding occurs and may lead to a better understanding of the social structure of adult males.

NR12 and NR13. Preserve a permanent record of the genetic composition of the existing monk seal population.

The present population could either grow or decline, with or without management intervention, due to a number of factors. Tissues could be obtained for analysis of certain genetic information at this time by collection of the tissue plugs resulting from tagging of pups. These could be stored in an appropriate manner for culturing and examination as well as other tests.

NR14. Determine the time-energy budget of adult male monk seals.

Mobbing is not energy efficient unless it represents the only means these males can breed. The cost/benefit ratio seems high, but metabolic information is essential in order to determine the actual energy costs of this activity versus other "normal" activities.

Appendix 6.--List of priority activities.

1. Behavior modification
 - annual pattern testing
 - acute tests in captivity
 - delivery in captivity
 - field development
2. Tagging
 - Maintain identifications
 - (NR3) Tag at Laysan, mark mobbers
 - Tag evaluation--cold brand, etc.
3. Patterns of association and distribution
 - (DA1) Patterns of male abundance
 - (DA5) Spatial distribution relative to habitat
 - (DA11) Sex ratio
 - (DA13) Determine association patterns of AF's
 - (DA14) Distribution of post-weaned females
4. Life history/modeling
 - (NR2, DA4) Reproduction/survival and movement of adult females
 mobbed and not-mobbed
 - (DA3) Project population and compare with survival rates
5. (NR4) Age mobbers and dominants
6. Estrus--captive
 - (NR9) Monitor various parameters
 - (NR10) Behavioral activity patterns
7. Comparative study
 - (NR1, DA15) Condition indices of animals including of
 wounds, scars, etc.
8. Estrus--in field
 - (NR5) Determine in field when estrus is occurring
 - (DA6) Investigate onset of estrus
 - (DA8) Focus on post-weaning females
 - (DA9) Correlate date of pupping, etc.
 - (NR11 note: added 20 Feb.) Measure underwater vocalizations to
 final distribution of seals in the water
9. Monitor male behavior at Kure.

Appendix 7.--Behavioral modification--outline of comments on approach and evaluation criteria.

- A. Captive trials on methodology (2 years):
 - 1. Monitor normal testosterone cycle in adult male.
 - 2. Perform short-term dose trials (1987).
 - If no response to treatments, stop and evaluate.
 - If response appropriate and no apparent side effects, continue.
 - 3. Perform long-term dose delivery trials to select optimal drug, dose, and delivery method (1988).
 - If response is appropriate for field use, proceed.
 - If response not acceptable for field use, evaluate and return to short-term trials, if other chemical methods available.
 - Based on findings above, a pilot field trial may be necessary.
- B. Field deployment (1-2 years):
 - 1. Treat 50% adult males at Laysan Island.
 - Treat known mobbers.
 - Do not treat high order dominant males.
 - If no apparent response in treated males, re-evaluate dose, delivery, etc.
- C. Criteria for success in the field:
 - 1. Scarring, injuries, mobbings reduced.
 - 2. No treated males involved in mobbings.
 - If two mobbings involve same treated males, stop or modify.
 - 3. Significant increase in number of adult females over 3-year period.
 - 4. Association/behavior pattern of adult males becomes more "normal"--normal to be defined.
 - 5. Monitor whether untreated males mob.
- D. Criteria for stopping/re-evaluating field work:
 - 1. Sex ratio becomes 1:1.
 - 2. Pup production declines.
 - 3. Treated males are killed in mobbings. Set an acceptable limit: 75%(?). Injury of treated males is acceptable.
 - 4. If mobbings and male inflicted injuries continue at current frequency or increase--stop.
 - If rate of decrease of these is slow, consider physical removal.

Appendix 8.--How priority actions 2-9 influence behavior modification.

2. Tagging
 - a. Tag mobbers at Laysan, maintain identities
 - b. Evaluate effects of mobbing:
 - By summer 1989, analysis of reproductive success and survival rates of mobbed and non-mobbed adult females
 - By 1987 season, begin tagging. Need permit modification (MARCH).
3. Patterns of association and distribution
 - a. Adult males
 - b. Adult sex ratio. Analysis for each island before behavioral modification
 - c. Spatial distribution
 - d. Hauling patterns of mobbed and non-mobbed females
 - e. Post-weaning female distribution
 - f. Counts of age/sex by December 1988
4. Reproduction survival modeling
 - a. Success--if reproduction and/or survival of mobbed non-mobbed changes
 - b. Model--used to support survival estimate
5. Ages of mobbers and dominants
 - a. Who you treat; done by December 1988
6. Estrus--captive
 - ..no effect on field plans
7. Comparative study
 - a. Which males you treat; March 1989
 - b. Success criteria; December 1989
8. Behavior associated with estrus in field
 - a. Which males not to treat; March 1989
 - b. When to treat; March 1989
9. Monitor male behavior at Kure
 - a. Data may affect decision on which males to treat

Appendix 9A.--Ranking of priority activities.

Task	PERSON												Total	Rank
	1	2	3	4	5	6	7	8	9	10	11	12		
Male behavior at Kure	4	5	4	1	2	5	4	3	1	2	1	5	37	8
Behavior modification	3	4	5	5	5	4	5	4	5	3	5	5	53	2
Tagging	5	5	5	5	3	5	5	5	4	5	5	4	56	1
Association/distribution	4	1	5	4	1	3	4	3	2	5	3	4	39	5
Reproduction/survival	4	3	4	3	4	5	5	5	3	5	5	5	51	3
Age of mobbers	1	2	1	2	4	3	2	3	2	2	4	4	30	9
Estrus--in field	5	2	5	4	3	4	3	2	4	2	4	3	41	4
Comparative study	2	3	5	3	2	5	5	2	3	3	4	2	39	5
Analyze behavior data	3	1	5	3	3	4	3	2	4	4	3	3	38	7

Appendix 9B.--Priority activities ranked into three groups.

	RANK GROUP		
	1	2	3
Tagging	x		
Behavior modification	x		
Life history/modeling	x		
Estrus--in field		x	
Comparative study		x	
Patterns of association and distribution		x	
Analyze behavior data		x	
Monitor male at Kure		x	
Age of mobbers and dominants			x